Pesticides in the Surface Waters of Chittenden County

A Joint Report of:
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Introduction:

Pesticides are widely used by Vermont homeowners, commercial landscapers, and farmers, but relatively little monitoring data exist to evaluate whether these potentially harmful products are entering Vermont's lakes and streams. This is especially true for urban and suburban areas where homeowner use is largely unregulated. Available information from surveys and studies conducted by the University of Vermont (UVM), United States Geological Survey (USGS), and the Vermont Department of Agriculture, Food and Markets (VDAFM), has shown that some pesticides are found in streams, edge-of-field surface run-off, and groundwater. In 1999, VDAFM detected turf (includes lawns and golf courses) herbicides in streams adjacent to a residential complex immediately following a commercial landscape application.

The presence of a pesticide in the water does not necessarily indicate significant environmental risk. The degree of environmental risk will generally be related to the magnitude of the concentrations that the pesticides reach in Vermont waters and the frequency and duration at which those concentrations occur. Currently, there are almost no data to address the significance of these risks for Vermont waters. Determining environmental risks is an essential part of evaluating the success of current pesticide use regulations. This study was undertaken as a first step toward developing a database that could be used to evaluate environmental risk and to assess the effectiveness of current pesticide regulations.

Project Description:

Data were gathered from the developed areas of Chittenden County to:

1) summarize commercial pesticide use and patterns, targeting lawn care pesticide products, in this area;
2) characterize targeted pesticides in streams and rivers discharging to Lake Champlain at a number of locations where intensive pesticide use is known to occur;
3) provide estimates of the occurrence of targeted pesticides in storm water discharges to Lake Champlain from a variety of urban/suburban areas where homeowner and commercial pesticide applications are known to occur; and
4) evaluate potential adverse effects from targeted pesticides in surface waters by conducting toxicity tests on water samples in conjunction with pesticide analyses.

Methods and Results:

Lawn care pesticide products and use patterns: The pesticides that were the focus of this survey are commonly found in products used in and around the home by both private homeowners and commercial landscape applicators. Many are also commonly used in agriculture. The initial list was selected based on best professional judgment of VDAFM personnel and reporting data provided by commercial applicators in Chittenden County (**Table 1**). It included the following chemicals:

1) **2,4-D, MCPP, MCPA, and Dicamba** - Broad leaf weed control by commercial applicators and homeowners. Most "weed and feed" products contain these active ingredients.

2) **Pendimethalin** - Used for crabgrass control in turf and corn. Most commonly used product for crabgrass control.

3) **Triclopyr** - Broad leaf weed control used in utility maintenance, turf, and by homeowners for brush control.

4) **Dacthal** - Was commonly used as pre-emergent herbicide for grass control in turf and for weed control in fruit and vegetable farming. Use of dacthal in Vermont is restricted to certified applicators; homeowners may continue to apply the dacthal they have in hand. No commercial use was reported in Chittenden County in 1999.

5) **Chlorpyrifos** - Commonly used insecticide in turf and for indoor/outdoor pest control. Legal use of this product in and around the home will end December 31, 2001.

6) **Diazinon** - Commonly used insecticide (30% of the homeowner insecticide market) in and around the home. Most use is by homeowners for ants, and garden and turf insects. No commercial use was reported in 1999. Legal use of this product in and around the home will end December, 2004.

7) **Malathion** - Commonly used insecticide for home and garden use.

Table 1. Commercial use of common pesticides in Chittenden County in 1999. Use is reported as pounds of active ingredient. Currently the most reliable data on pesticide use in Chittenden County is based on the required reporting of amount used by commercial pest control companies. The data in this table does not include any pesticides applied by homeowners or private agricultural applicators. 1999 is the latest year for which full data are available.

	turf (non-golf)	golf	structural	ornamental	corn	field and forage	utility	TOTAL
Pendimethalin	2361	33			1266	40		3700
Chlorpyrifos	1432	9	12	0.5				1454
MCPA	748	27						775
MCPP	308							308
2,4-D	135	27			6	0.6		169
Triclopyr	29						120	149
Dicamba	75	4.5			53			133
Malathion	2			3				5
Dacthal	No Reported Commercial Use in 1999							
Diazinon	No Reported Commercial Use in 1999							

Sample site selection and sampling methods: Samples were collected during rainfall events after known commercial pesticide applications and following periods of expected maximum homeowner activity (e.g. the first storm event following the Fourth of July holiday). For comparison, some samples were also collected during drier periods between rainfall events.

Samples were collected by hand. For wet weather sampling, grab samples were collected at 30-minute intervals during the period of rising flow in the streams and combined into a single sample for analysis. During dry weather, single grab samples were collected.

Three general use scenarios were evaluated:

1. A multi-family low-rise residential development with a unit density of 8 to 12 units per acre that used a commercial landscaping service:. Samples were collected from storm water draining the 42-acre site during the first significant rainfall following an early spring herbicide treatment (May 13, 2000) and during the first rainfall following the Fourth of July weekend (July 9, 2000). Samples were collected by hand at several points where storm water run-off exited the property.

2. Englesby Brook, a small urban stream: Three sites were situated along the upper, middle, and lower portions of the stream. The upper reaches are dominated by a golf course. The middle and lower sections pass through a variety of residential, suburban, and urban settings. The lower reaches drain into Lake Champlain. Samples were collected during storm events on May 13, July 9, and September 12, 2000.

3. Six storm water drains located throughout the City of Burlington and discharging directly to Lake Champlain or the Winooski River: The areas drained included a range of size and land use characteristics. Five and four drains were sampled during the July 9 and September 12 storm events, respectively. Two sites were sampled on September 1 during dry weather conditions.

Analytical methods and results: Both the acid herbicides (2,4-D, MCPP, MCPA, dicamba, triclopyr, and dacthal metabolites) and the neutral pesticides (diazinon, pendimethalin, chlorpyrifos, and malathion) were analyzed in the VDAFM laboratory using modified USEPA protocols (Methods 614 and 512.2) with gas chromatograph and mass spectrometer instrumentation.

A total of 22 samples from 10 sites were analyzed. Five of the ten target analytes -- MCPA, dicamba, triclopyr, chlorpyrifos, and malathion -- were not detected in any of the samples. The remaining five target analytes were detected at least once during the study. The following table summarizes the findings.

Compound	Type	MDL[1] ppb	Sample Detects	Site Detects	Max. ppb	Min. ppb	A-WQG[2] ppb	Detects[3] >A-WQG
2,4-D	H	0.1	3 of 22	3 of 10	162	0.27	120	1
MCPP	H	0.1	4 of 22	3 of 10	115	0.19	1860	0
Dacthal [4]	H	0.1	3 of 22	2 of 10	0.4	0.14	310	0
Diazinon	I	0.06	2 of 22	2 of 10	0.22	0.08	0.30	0
Pendimethalin	H	0.05	2 of 22	2 of 10	2.9	0.21	2.10	1
MCPA	H	0.1	0 of 22	ND	ND	ND	12.0	ND
Dicamba	H	0.1	0 of 22	ND	ND	ND	420	ND
Triclopyr	H	0.1	0 of 22	ND	ND	ND	1860	ND
Chlorpyrifos	I	0.05	0 of 22	ND	ND	ND	0.083	ND
Malathion	I	0.05	0 of 22	ND	ND	ND	1.0	ND

H = herbicide, I = insecticide

1. MDL is the minimum analytical detection limit
2. A-WQG is the Vermont acute water quality guideline indicating the concentration at which acute effects on sensitive aquatic species may occur when exposure exceeds one hour.
3. The number of detections exceeding the acute water quality guideline.
4. Dacthal metabolites were analyzed for but results are reported as dacthal parent compound.
5. ND = None Detected

Toxicity testing methods and results: Toxicity of samples was evaluated by UVM by measuring the survival and reproduction of *Ceriodaphnia dubia,* a water flea, in a seven-day test according to U.S. Environmental Protection Agency protocols (USEPA, 1989). No toxicity tests were conducted on the May 13 samples. Five samples each from the July 9 and September 12 sampling events were tested. One sample from the September 1 dry weather sampling was tested.

No significant acute effects (mortality) were observed in any sample tested. Of the two samples in which a pesticide was detected at a concentration greater than the acute water quality guidance value, one (2,4-D at 162 ppb) was included in the toxicity testing. No acute or chronic effect was observed in that test. Although most tests showed only moderate inhibition of reproduction, strong reproductive inhibition was observed in three of five samples collected during the July 9 storm event. Pesticides (MCPP, dacthal metabolites and traces of diazinon) were detected at these three locations at levels below the acute water quality guidance values. Other toxic substances such as trace metals likely present in the samples may have contributed to the reproductive impairment noted.

Discussion:

One or more of the target pesticides were detected in thirteen of twenty-two samples collected and at seven of the ten sites sampled. A maximum of three of the ten target pesticides were found in any single sample. Three of the four turf herbicides most commonly reported by commercial applicators (pendimethalin, MCPP, and 2-4-D) were detected at least once (a total of 12 detections) at half the study sites. It is likely that these products were used by homeowners as well, although no data were gathered on homeowner use. Two pesticides detected in these samples exceeded applicable acute water quality guidelines: 2,4-D was detected in a storm drain at a level 1.35 times the acute guideline and pendimethalin was found in run-off from the residential units following a commercial application of that product at 1.38 times the acute guideline. All other herbicide detections were significantly lower than acute guidelines. Dacthal metabolites were detected at two storm drain sites, although there was no reported commercial use of this product. Toxicity testing conducted on the sample containing 2,4-D at 1.35 times the acute water quality guideline showed no measurable effect on the survival or reproduction of *Ceriodaphnia*.

The most commonly reported insecticide, chlorpyrifos, was not detected in any sample. Diazinon, with no reported commercial use, was detected at two locations on Englesby Brook during one sampling event. Concentrations detected were 27 and 73 percent of the acute water quality guideline for diazinon. Diazinon is likely to be the most common insecticide used by homeowners.

Four products, accounting for 50 percent of the total project detections, were found in Englesby Brook; no detections were above acute water quality guidelines.

There were no acute responses (e.g., no mortality) during the toxicity testing; however, three of five samples collected during the July storm event strongly inhibited reproduction. Pesticide levels in these samples were low, therefore, the response could be the result of other contaminants in the storm water; elevated concentrations of several trace elements, primarily copper, lead and zinc, were found in these samples.

Summary and Recommendations:

Pesticides were found in 41 percent of the samples collected. Of 220 individual product analyses performed, 206, or 94 percent, were below analytical detection limits. Two chemicals were found at concentrations that exceeded acute water quality guidelines on one occasion. These results indicate that pesticides commonly used for turf management are present in some streams in developed areas of Chittenden County at certain times. Because some chemicals appeared at concentrations that were above water quality guidelines, their occurrence may pose some risk to aquatic communities in those waters.

To clarify environmental risks, additional sampling should be implemented in order to determine how long the critical concentrations of these products persist in lakes and streams and how often these concentrations occur. Chronic exposures to lower concentrations of contaminants can also cause harm. In this limited study, at most sites where samples were collected on multiple dates, pesticides were detected on only one of the dates. This suggests that the occurrence of pesticides in these waters may be relatively short lived. Future sampling should be conducted which would focus on determining the frequency of occurrence of these chemicals in surface waters, the amount of time that they remain in the system at critical concentrations, and the potential toxic effects. This same collaborative will conduct additional sampling in 2001 to examine temporal patterns of pesticide occurrence specifically in Englesby Brook.

Suggested Information Sources:

1. Bailey, HC et al, “Diazinon and Chlorpyrifos in Urban Waterways in Northern CA, USA”, Env. Tox. & Chem., 19(1) pp. 82-87, 2000

2. Hoffman, RS, PD Capel,, SJ Larsen, “Comparison of Pesticides in Eight U.S. Urban Streams”, Env. Tox. & Chem., 19(9) pp. 2249-2258, 2000

3. http://www.cciw.ca/glimr/data/conc-urban-pesticides/intro.html

4. Lee, GF, “Screening Urban Pesticide Use for Potential Water Quality Impacts”, G. Fred Lee and Associates, El Macero, CA, June 1998)

5. USGS. “Pesticides Detected in Urban Streams During Rainstorms and Relation to Retail Sales of Pesticides in King County, Washington”. USGS Fact Sheet 097-99. April 1999.

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